

**CLAIMS**

What is claimed is:

- 1 1. A magnetic head, comprising:
  - 2 a sensor having a free layer, the free layer having a magnetic moment;
  - 3 hard bias layers positioned towards opposite track edges of the sensor, the bias
  - 4 layers stabilizing the magnetic moment of the free layer;
  - 5 an antiparallel (AP) pinned layer structure positioned toward each of the hard bias
  - 6 layers, each AP pinned layer structure having at least two pinned layers
  - 7 having magnetic moments that are self-pinned antiparallel to each other,
  - 8 each AP pinned layer structure stabilizing a magnetic moment of the hard
  - 9 bias layer closest thereto; and
  - 10 an antiferromagnetic layer positioned toward each of the AP pinned layer
  - 11 structures, each antiferromagnetic layer stabilizing a magnetic moment of
  - 12 the pinned layer closest thereto.
- 1 2. A head as recited in claim 1, wherein the hard bias layers each include at least Co.
- 1 3. A head as recited in claim 2, wherein the hard bias layers are constructed from a
- 2 material selected from a group consisting of CoPt and CoPtCr.

1 4. A head as recited in claim 1, wherein the antiferromagnetic layers each include at  
2 least PtMn.

1 5. A head as recited in claim 1, wherein the pinned layers of the AP pinned layer  
2 structure each include at least Co, wherein the pinned layers are separated by a  
3 layer of Ru.

1 6. A head as recited in claim 5, wherein the antiferromagnetic layers are constructed  
2 from PtMn.

1 7. A head as recited in claim 1, wherein the pinned layers of the AP pinned layer  
2 structure each include at least Fe, wherein the pinned layers are separated by a  
3 layer of Cr.

1 8. A head as recited in claim 7, wherein the antiferromagnetic layers are constructed  
2 from PtMnCr.

1 9. A head as recited in claim 1, wherein the AP pinned layer structures are  
2 positioned between the hard bias layers and the antiferromagnetic layers.

1 10. A head as recited in claim 1, wherein a magnetic moment of each pinned layer  
2 closest to the associated hard bias layers is oriented parallel to a magnetic moment  
3 of the associated hard bias layer.

- 1 11. A head as recited in claim 1, wherein the antiferromagnetic layers each have a
- 2 thickness of at least about 50 Å measured in a direction perpendicular to a plane
- 3 of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned
- 4 layer structures has a thickness less than about 25 Å.
  
- 1 12. A head as recited in claim 1, wherein the antiferromagnetic layers each have a
- 2 thickness of at least about 100 Å measured in a direction perpendicular to a plane
- 3 of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned
- 4 layer structures has a thickness less than about 15 Å.
  
- 1 13. A head as recited in claim 1, wherein an Hc of each of the bias layers is at least
- 2 two times an Hc of hard bias layers in a structure identical to the head of claim 1
- 3 but without antiferromagnetic layers.
  
- 1 14. A head as recited in claim 1, wherein an Hc of each of the bias layers is at least
- 2 three times an Hc of hard bias layers in a structure identical to the head of claim 1
- 3 but without antiferromagnetic layers.
  
- 1 15. A head as recited in claim 1, wherein the head forms part of a CIP GMR sensor.
  
- 1 16. A magnetic head, comprising:
- 2 a sensor having a free layer, the free layer having a magnetic moment;

3        hard bias layers positioned towards opposite track edges of the sensor, the bias  
4        layers stabilizing the magnetic moment of the free layer, wherein the hard  
5        bias layers each include at least Co;  
6        an (AP) pinned layer structure positioned toward each of the hard bias layers,  
7        each AP pinned layer structure having at least two pinned layers having  
8        magnetic moments that are self-pinned antiparallel to each other, each AP  
9        pinned layer structure stabilizing a magnetic moment of the hard bias layer  
10      closest thereto; and  
11      an antiferromagnetic layers positioned toward each of the AP pinned layer  
12      structures, each antiferromagnetic layer stabilizing a magnetic moment of  
13      the pinned layer closest thereto, wherein the antiferromagnetic layers each  
14      include at least PtMn;  
15      wherein an Hc of each of the bias layers is at least two times an Hc of hard bias  
16      layers in a structure identical to the head of claim 1 but without  
17      antiferromagnetic layers.

- 1        17. A head as recited in claim 16, wherein the hard bias layers are constructed from a  
2        material selected from a group consisting of CoPt and CoPtCr.
- 1        18. A head as recited in claim 16, wherein the pinned layers of the AP pinned layer  
2        structure each include at least Co, wherein the pinned layers are separated by a  
3        layer of Ru.

- 1 19. A head as recited in claim 18, wherein the antiferromagnetic layers are
- 2 constructed from PtMn.
  
- 1 20. A head as recited in claim 16, wherein the pinned layers of the AP pinned layer structure each include at least Fe, wherein the pinned layers are separated by a layer of Cr.
  
- 1 21. A head as recited in claim 20, wherein the antiferromagnetic layers are
- 2 constructed from PtMnCr.
  
- 1 22. A head as recited in claim 16, wherein the AP pinned layer structures are positioned between the hard bias layers and the antiferromagnetic layers.
  
- 1 23. A head as recited in claim 16, wherein a magnetic moment of each pinned layer closest to the associated hard bias layers is oriented parallel to a magnetic moment of the associated hard bias layer.
  
- 1 24. A head as recited in claim 16, wherein the antiferromagnetic layers each have a thickness of at least about 50 Å measured in a direction perpendicular to a plane of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned layer structures has a thickness less than about 25 Å.

- 1 25. A head as recited in claim 16, wherein the antiferromagnetic layers each have a
- 2 thickness of at least about 100 Å measured in a direction perpendicular to a plane
- 3 of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned
- 4 layer structures has a thickness less than about 15 Å.
  
- 1 26. A head as recited in claim 16, wherein an Hc of each of the bias layers is at least
- 2 three times an Hc of hard bias layers in a structure identical to the head of claim
- 3 16 but without antiferromagnetic layers.
  
- 1 27. A head as recited in claim 16, wherein the head forms part of a CIP GMR sensor.
  
- 1 28. A magnetic storage system, comprising:  
2 magnetic media;  
3 at least one head for reading from and writing to the magnetic media, each head  
4 having:  
5 a reading portion having the structure recited in claim 1;  
6 a write element coupled to the sensor;  
7 a slider for supporting the head; and  
8 a control unit coupled to the head for controlling operation of the head.
  
- 1 29. A magnetic storage system, comprising:  
2 magnetic media;

- 3        at least one head for reading from and writing to the magnetic media, each head
- 4        having:
- 5            a reading portion having the structure recited in claim 16;
- 6            a write element coupled to the sensor;
- 7            a slider for supporting the head; and
- 8            a control unit coupled to the head for controlling operation of the head.